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theless, a little thought certainly shows that some such system as this may be a necessity in the near future and, if for no other reason, should receive earnest attention and discussion. The system proposed by Dr. Needham has obvious advantages: By grouping closely related genera (becoming subgenera) under the old name of the genus when used in its widest sense, two of the fundamental reasons for the existence of nomenclature are reached, namely, stability and ease in identification and in grasping the relations of the various units at a glance. But, to my mind, the system has nothing at all to do with stability unless this fundamental change is instituted. All will grant, I think, that stability is fundamental, as is also ease or at least possibility of identification. I believe, too, that all will concede that neither is possible without what may be called "rigidly" defined genera (=groups), genera which all are willing to rank as such and which all will be able to recognize (perhaps they would be equal to present-day subfamilies at least).

These genera or groups being firmly established by universal acceptance and concise description, then the application of the symbols would doubtless save an immense amount of space. Otherwise, I am certainly at a loss to find any other advantages which they may have. Synonymy nor anything else is simplified by saying that $5=4$ instead of *leucop-sallis* = *viridis*. The only thing that matters is whether the statement is true or not. You may call 5 anything that you wish without changing what it represents. And is it not true that most of our troubles cluster about the fact that we have been unable to find out what authors have meant to represent?

The objections to involved nomenclature entered by the zoologist and biologist are entitled to much consideration, but we should not lose sight of the fact that the present systematic unit—the species—was founded by themselves and seemingly we still find an endless number of them. If it is true that they exist it is our duty to keep on recording them. Whether we call them by symbols or names isn't to the point at all. The gist of the

matter is, shall the conception of the systematic unit be changed from "natural" species to conceived genera? Will any biologist deny that species exist. Why, therefore, should they wish to escape from them? It is true it is impossible to know all of them nor even their names! But who wants to do this. The fact that they exist is true, or else our conception, or rather perception, of a species is all wrong. Now, if it is true that they exist, I believe that it is necessary that they be represented by names or else symbols. Thus, whether names or symbols are used, either would have to be used an equal number of times, but the symbols would be shorter, that is all. It is not the jungle of names that masters us, is it? Rather, is it not the jungle of things? To simplify, natural laws, not symbols, are needed.

Therefore, it seems to me that the fundamental plan suggested by Dr. Needham, that of falling back upon the old genera and their names, is the only way out of the confusion, present and past. As for the symbols, they are preferable only in so far as they have a tendency to simplify, not our knowledge, which they are certainly unable to do here, but our working methods, time and space.

A. ARSÈNE GIRAULT

URBANA, ILL.,

January 9, 1911

ON FACTORS CONTRIBUTING TO A LOW SCIENTIFIC PRODUCTIVITY IN AMERICA

A FEW months ago I offered some criticisms on a paper by Professor Gunn which appeared in *SCIENCE* for October 28, 1910, under the caption, "American Educational Defects." My criticisms were directed chiefly to the method adopted by Professor Gunn, and he has very properly retorted¹ that I should not make too much of the matter of method unless I am prepared to dissent from the practical outcome of his study.

Now so far as this outcome was to the effect that the level of scientific and scholarly productivity in this country is unsatisfactory by comparison with that in certain European

¹ *SCIENCE*, January 20, 1911, N. S., XXXIII., 107.

countries, I am not prepared to dissent. I do indeed believe that Professor Gunn's picture is overdrawn, when he describes our achievements in pure science as "insignificant," for it is easy to point to achievements of very high grade, even in such branches as mathematical physics and philosophy, while of recent years there has appeared a considerable volume of quite respectable work. Still, I should admit that the work of very high quality has been too small in amount, and that the volume of recent work suffers somewhat in an appraisal of its quality. I should indeed be inclined to make a further reservation on this last point, as far as my own acquaintance with scientific literature goes; for in my own field of experimental psychology, which has hitherto been chiefly cultivated in Germany and in America, I am unable to detect any pronounced superiority of the German work. The Germans do, certainly, manage to give their contributions a more important sound; their articles are more extended, and run out almost indefinitely into discussion and theoretical considerations; but much of this is of little real value, and many an American paper of modest length contains as much of real contribution to knowledge as does its German analogue of a hundred or two hundred pages. However, let us freely admit that, when we consider the number of men here who might be expected, from their training and their positions, to be scientific producers, we find the total productivity surprisingly small. There is much to indicate that this is the fact: so numerous are the cases of young men who have produced a creditable doctor's dissertation and obtained a college position in their specialty, but from whom nothing further is heard in the way of original contribution; and so numerous also are the cases of men of proved ability, who, after a few years of activity and after winning a professorship of dignity, allow their output to cease. Good minds and good opportunities appear to be going to waste, and the problem of the causes of this condition is one of the highest importance to those who are interested in the advancement of science.

It is a problem which deserves treatment by the most painstaking methods of science; unfortunately, I can make no great claims for my own method, for I have by no means conducted researches on the large scale demanded by the complexity of the problem. I have, however, for a considerable number of years been keenly interested in this particular problem, and am prepared to adduce a certain number of facts, which, as facts, will scarcely be called in question, and which I shall try to show are probably pertinent.

I will first adduce my list of facts, in summary form.

1. The economic rewards for scientific production, and punishments for lack of it, have been smaller here than elsewhere.

2. Similarly with other social rewards and punishments.

3. The rapid expansion of our educational system has created a demand which has absorbed the whole supply of even reasonably qualified men.

4. This educational expansion has been but a feature of the general national expansion, and the general demand for men of ability has operated still further to reduce the keenness of academic competition, and so to lower the standard of academic success.

5. This rapid expansion, in the presence of our decentralized form of governmental control and generally fluid condition, has made the business of the educational and scientific promoter one of great importance, has operated to give the greatest economic and social prizes to the promoter, and has caused scientific men to spend their time running errands in the interest of science rather than prosecuting their individual research.

6. The educational interest, as distinguished from the strictly scientific, has been strong among us, and has led to a considerable deflection of effort from the work of science.²

²There is another probable fact, which I do not include in the list because I am not sure of it, and because it could be determined by suitable inquiry, in advance of which it is best not to guess at the fact. The probability is that our young men do not begin to specialize so early as their scientific brethren in Europe, and if this is

Lest I should be accused of altogether neglecting principles in my zeal for facts, I will also mention a few general principles which can properly be employed in reasoning from the above facts:

1. The law of supply and demand.
2. The law of the value, as incentives, of rewards and punishments.
3. The law of divided energy, according to which a man can not do so much in a given line if his time and energy are largely devoted to something else.

The great fact of rapid expansion is perhaps the most important of all. Since the most obvious feature of this expansion has been that of the economic development of the country and of the growth of industries, the fact is usually hit off as commercial expansion, and the effort made to deduce all our peculiarities and deficiencies from our commercialism. But the real fact is expansion, a fact, it is probably of great importance. Our own delay in getting the young man fairly launched on his scientific career is partly due to our superstition that the traditional four years of college marks a minimum of time to be devoted to "general culture," after which, only, should specialization begin. Meanwhile, through the raising of the standards for admission to college, the period of specialization has been deferred to about the age of 22. But besides this, it often happens that a man just leaving college and bent on a scholarly career is led to believe that the best step for him next to take is to teach in a secondary school; and thus the age at which he enters on really advanced study is likely to be delayed to 25. From observation of men studying for their doctor's degree, I am convinced that the man who goes straight on from college to the university is usually the one who comes off best in his graduate study. The years immediately following the age of 20 are of great value for the ready assimilation of knowledge, and, moreover, the most original period of a man's life is likely to follow close upon these years; and unless he has good command of his specialty by the age of 25 or 27, he is rather unlikely ever to have many original ideas on the subject. I am convinced that specialization, for any young man whose bent towards a scholarly pursuit is sufficiently marked to warrant urging him to undertake it, should not be delayed much beyond the age of 20.

not commercialism—expansion in all directions. A necessary result of this expansion, and a result abundantly in evidence, is that the demand for labor of all kinds, and not least for the labor of intellectually able men, has been great in relation to the supply. The economic reward for intellectual ability has, of course, been much greater in many other lines of work than in the academic, and this has certainly further limited the supply available for scientific pursuits. For example, it has been, and is, difficult to man the laboratory departments of our medical schools, for the reason that the rewards awaiting the successful physician, in practise, have been far in excess of anything he could hope for in research. The financial reward for scientific work is everywhere less than the reward for equal accomplishment in other lines; but here this difference is accentuated. In spite of this fact, scholarly pursuits continue to attract a very considerable number of really able men. The men are attracted in part by the freedom of the academic life, in part by the undoubted prestige attaching to good academic positions, and in largest measure, no doubt, by the work itself. Improvement of the general economic status of university and college teachers is of course greatly to be desired in the interests of broadening the labor market for this highly important sort of work; but that is by no means the key to the whole situation, for we are confronted with an able body of men, men who have proved, in many cases, their ability in original work, but who nevertheless leave much to be desired in the way of productivity.

The expansion of our educational system has, if anything, outstripped our commercial expansion. Universities have multiplied and grown enormously, teaching forces have been greatly augmented, and the demand for high-class men to fill academic positions has been ever on the increase. The demand has been large in proportion to the supply, so that every moderately equipped candidate has been assured of a post of some dignity. Promotion has been rapid, as far as it goes. In other words, the labor market for all grades of academic work has been relatively narrow, and

there has been an absence of keen competition either for the lower or for the higher positions. This is a necessary result of expansion, and, at any rate, it is a fact. The conditions, as regards competition, are very different in some European countries. A young man there must often serve a long apprenticeship in a very poorly paid position, and can only rise out of this difficult situation by overcoming keen competition. Our rather tame discussions of the work of our colleagues lack the keen note of economic competition which is often heard in European controversy. Here, we feel, there is room enough for all, and on an approximate equality. Here it makes comparatively little difference to a man, economically, whether his scientific work is mediocre or of eminent success. For while the ratio of demand to supply assures him of at least a moderately good position, there is nothing in the way of a very fine position to spur him forward. While mediocre men are better off here than in several other countries, very good men, in purely academic positions, are by no means so well off as elsewhere. In Great Britain, at least, there is a considerable number of professorships the financial value of which, when allowance is made for the different purchasing power of money, is fully the equivalent of eight to twelve thousand dollars. The financial value of these posts is well known throughout the kingdom, and, as they are permanent establishments, and are filled, when they fall vacant, in the open market, they act as a very effective stimulus to productivity. They act as a stimulus to a class of men whom it is most of all important to stimulate, and who, in our country, are subject to no such incentive—namely, to the men of greatest ability, who have already proved their power and have already achieved positions as good as any we have here to offer. Not only a high money value, but also great prestige, attaches to some of these chairs, because of the eminent men who have occupied them in the past. We have practically nothing to correspond to them; and this is, I believe, one of the great deficiencies of our system. Nowhere, it would seem, is the

punishment for idleness so light as in our academic life; and nowhere is the reward of productive industry so meager. I am far from contending that the mere financial reward is the sole stimulus to scientific production; but these prizes not only bring great financial relief; they are also the seal of success. I might paraphrase what I said a few sentences back by asserting that nowhere is there such a lack, as in our American academic life, of the tangible symbols of success and failure in scholarly work.

To punish mediocrity is scarcely within our power during a period of rapid expansion; but to reward proved merit is in our power. Why should not a university, numbering among its professors some one of the acknowledged leaders in American productive scholarship, simply double or triple his salary, at the same time doing all it can to strengthen his department, and thus secure to itself preeminence in that particular subject among all our universities; insuring, further, a continued preeminence by permanently establishing this distinguished chair and this thoroughly equipped department? It should be possible in this way for a university to attract a large share of the best graduate students in this department, and thus add further to the influence of the chief and to the attractiveness of his position. The combined prestige, influence and financial desirability of such a position would make it a prize for the competition of the ablest of the younger men. There is no reason why such prizes should not act as effective spurs here as elsewhere. Our effort has been devoted more to raising the general level of compensation and attractiveness of all professorial positions than to the recognition of eminent scholarly and scientific success. Certainly there is abundant need for raising the general level of salaries to keep pace with the changing ratio between money and other commodities. But the reward of eminent merit is a thing apart.

Another consequence of rapid expansion, under the decentralized and rather unorganized conditions of our national activity, in which such an interest as the educational must look out for itself, has been the evolution of

the organizer, agent and promoter. The most striking instance is the university president or chancellor. His function has been distinctly that of the promoter; and so important has this function appeared in a period of expansion that the largest rewards, both pecuniary and in the way of social standing and influence, have gone to the presidency, and some of the ablest and most efficient from the professional ranks have been drafted into administration. Since the duties of the president have been too exacting to allow a continuance of scholarly work, the result has no doubt been a considerable shrinkage in the volume of possible production. Further, ambitious young professors, observing which way the path of distinction led, have often set themselves to prove their ability in administration rather than in scientific production. Administrative opportunity has abounded throughout the educational system, and many who entered the system from love of science or literature have found their attention largely absorbed by matters of management and promotion. Much of this bustling administrative activity has been a necessary result of expansion, but much of it has been due to mere contagion and mutual emulation. The center of competitive activity has been shifted from scholarship to administration. Now all administrative work, however necessary in the circumstances and however ably performed, is but a means to the ends of scholarship and of education; and it seems a pity that so much of the best brains should go to the means and so little be applied directly to the ends in view. The head of a department, instead of entering his laboratory with the thought of his experiment uppermost in his mind, is first of all oppressed by the condition of his desk. When that is cleared up, he hopes to go ahead with his investigation; but the desk occupies him for so large a part of the day that the experiment is deferred till to-morrow. There is a tremendous dissipation of energy among university professors. We are always busy, but seldom get down to business. We are always busy trying to insure that the work of science be done, and leave little time to do the work

ourselves. We are so much occupied in contributing to the advancement of science that we are unable to make contributions to science.

The attention of our scholars has been deflected by educational as well as administrative interests. I am inclined to regard this, too, as a consequence of expansion. For our higher institutions of learning have expanded in faster ratio than the general population, and this means that we are undertaking to educate many who are not specially suited to a higher education. Since the net has been made finer, we are catching many small fish, and the educational problem is largely concerned with these small fish. Whatever be the explanation, there is no doubt of the fact that our university professors are more occupied in the effort to impart instruction and insure that the student derives some benefit from it than is the case in foreign universities. I have heard it said that whenever a group of European university men get together, they talk science, whereas we talk education. We are greatly concerned about the student, and largely about the poor student. This may be best in the circumstances, and I have no desire to attempt a rough and ready solution of so complicated a problem; but simply point out the undoubted fact that here is a factor in our comparative lack of scholarly production. With both the administrative and the educational interests so strong among us, we are prone to hover in the outskirts of scholarship, instead of plunging into the heart of it.

There is another aspect to the whole matter, for the universities are not the sole repositories and organizers of scholarship. Guilds of scholars have to be considered as a means of exciting to productivity. We have, indeed, few productive scholars outside of the universities, though this is at least partly due to the prestige which university professorships have among us, for it would be easy to name a score of scholars and scientific men who, though of independent means, have sought university connections, in order to have a definite standing in the scholarly world. College loyalty has been a strong force among us, and

the attachments of a professor have been mostly to his university rather than to the fellowship of his particular science. Of recent years, with the organization of national scientific societies, some change has occurred in this respect. It is to guilds of scholars, whether formally organized or not, that we must look for setting the standard of scholarly production. The fellowship of scholars can only be a matter of gradual development, and their standards also must grow and can not be suddenly and artificially raised; but there is plenty of evidence that the standards of our scholarly guilds have been rapidly improving, and they will probably continue to improve. Such guilds possess rewards and punishments of their own, for the standing of a man among his fellows is one of the strongest incentives to action. The standards of the guilds must eventually be the standards of the universities; and thus we hold in our own hands, quite apart from the momentary attitude of university authorities, a force capable of raising the level of our own work and that of our successors.

R. S. WOODWORTH

COLUMBIA UNIVERSITY

BIOLOGICAL TEACHING IN SECONDARY SCHOOLS

A MEETING of men interested in the advancement of biological teaching in secondary schools was held at the Harvard Union, Cambridge, on Saturday, February 4. Those present were Professor G. H. Parker, Harvard University; Principal Irving O. Palmer, Newton Technical High School; Dr. H. R. Linville, Jamaica (N. Y.) High School; R. H. Howe, Jr., Middlesex School; Samuel F. Tower, Boston English High School; S. Warren Sturgis, Groton School; Head Master Frank E. Lane and W. L. W. Field, Milton Academy. The relation of school biology to civics, the sequence of laboratory experiments, outdoor work with classes and college requirements were the topics informally discussed. The undersigned was authorized to communicate with other teachers with a view to establishing a series of conferences, perhaps to be held alternately in Boston and New York.

Correspondence is accordingly invited from interested readers of this notice.

W. L. W. FIELD

MILTON ACADEMY,
MILTON, MASS.,
February 6, 1911

SCIENTIFIC BOOKS

Questioned Documents. A Study of Questioned Documents with an Outline of Methods by which the Facts may be Discovered and Shown. By ALBERT S. OSBORN. With an Introduction by Professor JOHN H. WIGMORE. Two hundred illustrations. Rochester, N. Y., The Lawyers' Cooperative Publishing Co. 1910. Pp. xxiv + 501.

"Questioned Documents" is an admirably clear presentation of the application by experts of modern scientific methods to the study of handwriting. It gives a detailed exposition of the use in the identification of handwriting of enlarged photographs taken in various lights, of the document microscope and of the color microscope designed for recording the tints and shades of ink. The instruments and appliances used in getting accurate measurements of such details of writing as the width of the line-stroke and the slant of various parts are also described. Particularly interesting is the suggestion of the new application of stereoscopic photography in such a way as to determine in disputed handwriting the sequence of crossed lines, the time-relation of writing to folds in paper and the presence of erasures and changes in paper-fiber.

The purpose of the book is practical—a very successful attempt to present the science of handwriting in relation to law, an attempt which constitutes a new and profitable departure in legal literature. The author would arouse the interest of the trial lawyer in, and his intelligent comprehension of, the problems involved in questioned documents, so that he may be better qualified to deal with situations involving such matters. Those interested in the pure science of handwriting will, none the less, find much to learn from the author relative to its accurate measurement and analysis. The reviewer is acquainted with no other